Revised: 7/14/03 Laboratory:_____ Inspector(s): _____ Date:_____

S___F___N/A___

Dry Preparation for Particle Size Analysis & Soil Constants
ASTM D 421-85 (98)

4.1. Balance, sensitive to 0.1-g ___
4.2. Mortar and Rubber-Covered Pestle ___
4.3. Sieves, No. 4, No. 10, and No. 40, conforming to ASTM E 11 ___
4.4. Sampler **(optional)**, riffle or sample splitter, for quartering ___

Sampling:
5.1. Air dry ___ ; break-up w/mortar and pestle ___ ; representative sample by quartering ___ or sampler ___
5.1.1. Particle-Size Analysis, material passes No. 10 sieve, 115-g (sandy soils) ___ ; 65-g (silt/clay soils) ___
5.1.2. Tests for Soil Constants, material passes No. 40 sieve:
Liquid limit, 100-g ___
Plastic limit, 15-g ___
Centrifuge moisture equivalent, 10-g ___
Volumetric shrinkage, 30-g ___
Check tests, 65-g ___

Procedure:
6.1. Record mass of total sample ___ ; Separate with No. 10 sieve ___
6.2. Wash, dry, and weigh (record as mass of coarse material) ___ ; Sieve on No.4 sieve, record mass ___

Data sheet (for recording masses) ___

S___F___N/A___

Particle Size Analysis
ASTM D 422-63 (98)

3.1. Balance
Material < No. 10 sieve, sensitive to 0.01-g ___
Material > No. 10 sieve, sensitive to 0.1% of mass ___
3.2. Stirring apparatus:
Mechanical stirrer ___
Air-jet dispersion ___
3.3. Hydrometer conforming to ASTM E 100-95, ASTM 151H ___, or ASTM 152H ___
3.4. Graduated cylinder, 1000-mL, 36 ± 2-cm height to 1000-mL mark ___
3.5. Thermometer accurate to 1°F (0.5°C) ___
3.6. Sieves conforming to ASTM E 11-95 (see page S-27) ___
3.7. Water bath or constant-temperature room, ~ 68°F (20°C) ___
3.8. 250-mL beaker ___
3.9. Timing device with second hand ___
4.1. Dispersing agent, sodium hexametaphosphate, 40-g/L solution with water in 4.2 ___
4.2. Distilled or de-mineralized water ___

Procedure:
5.1. Obtain sample in accordance with ASTM D 421: splitter ___ quarter ___
5.1.1.

	ASTM (retained on No. 10 sieve)	EM 1110-2-1906 App. V
Silts/clays	65-g ___	50-g ___
Sandy soils	115-g ___	50-g ___
3/8-in. (9.5-mm)	500-g ___	150-g ___
¾-in. (19.0-mm)	1000-g ___	1000-g ___
	½ -in.	300-g ___
1-in. (25.4-mm)	2000-g ___	2400-g ___
1½-in. (38.1-mm)	3000-g ___	8000-g ___
2-in. (50.8-mm)	4000-g ___	19000-g ___
3-in. (76.2-mm)	5000-g ___	64000-g ___

6.1. Material retained on No. 10 (2.00-mm):
6.2. Shake in nest of sieve ___; Check time, shake until < 1% passes in 1-min. ___

7.3. Composite correction factors used (2 temperatures) ___

9.1. Material passing No. 10 (2.00-mm) (Hydrometer test):
Sample size: clay and silts: 50-g ___, sand: 100-g ___
EM 1110-2-1906 App. V: Fat clay: 30-g ___, Lean clay/silts: 50-g ___, sandy soil: 75-g ___
9.2. Mix sample with 125 ml dispersing agent solution to suspend sample in distilled or de-mineralized water ___
10.1. Hydrometer test ___
11.1. Sieve analysis ___

12.1. Calculation/Report (table of percent finer than vs. grain-size in mm) ___

Data sheet (shows individual masses retained) ___

S___F___N/A___

Shrinkage Factors of Soils by the Mercury Method
ASTM D 427-98

Apparatus:
6.1. Evaporating Dish, porcelain, ~ 5.5-in. dia. ___
6.2. Spatula w/blade ~ 3-in. long by 0.75-in. wide ___
6.3. Shrinkage Dish, circular porcelain or metal, flat bottom, ~ 1.75-in. dia. by 0.5-in. high ___
6.4. Straightedge, steel, ~ 6-in. long ___
6.5. Glass Cup, ~ 2.25-in. dia. by 1.25-in. high, top rim ground smooth parallel to bottom of cup ___
6.6 Glass Plate, 3 metal prongs, 3-in. by 3-in. by 1/16-in. ___
6.7 Glass Plate, large enough to cover glass cup ___
6.8 Graduate, glass, capacity of 25 ml, graduated to 0.2 ml ___
6.9 Balance, sensitive to 0.1-g, class GP2, conforms to ASTM D 4753-95 ___
6.10 Mercury, enough to fill glass cup to overflowing ___
6.11 Shallow Pan, ~ 8-in. by 8-in. by 2-in. deep, nonmetallic (glass) ___

Procedure:
9.1. Place soil in evaporating dish, mix w/distilled water ___
9.2. Coat shrinkage dish w/petroleum jelly, silicone grease, etc. ___; Record mass of empty dish ___
9.3. Determine volume of mercury in shrinkage dish, glass graduate ___; divide mass by mass density ___
9.4. Record mass of dish and wet soil ___
9.5. Dry soil pat in air, oven-dry, and record mass of dish and dry soil ___
9.6.1 & 9.6.2. Determine volume of dry soil pat using mercury ___

Report:
11.1.2 Initial water content, to nearest whole number (omitting %), ___
11.1.3 Shrinkage limit, to nearest whole number (omitting %), ___
11.1.4 Shrinkage Ratio, to nearest 0.01 ___

Data sheet ___

S___F___N/A___

Moisture Density of Soil-Cement
ASTM D 558-96

4.1. Mold, metal, 4-in.: dia. 3.984-4.016-in. (101.2- 102.0-mm) ___ ; vol. 0.0329-0.0337-ft^3 (933-955-cm^3) ___ ; collar, detachable, approx. 2.5-in. in height ___
4.2.1. and 4.2.2 Rammer (manual or mechanical) Free fall: 11.94-12.06-in. (303.2-306.4-mm) ___ ; wt. 5.48-5.52-lb (2.49-2.51-kg) ___ ; face dia. 1.99-2.01-in. (50.67-50.93-mm) ___ ; Guide sleeve with ≥ 4 vent holes ≥ 3/8-in. (9.5-mm) and 90° apart ___ ; centered at 0.6875-0.8125-in. (17.4-20.6-mm) from each end ___ ;
Mechanical Rammer, Calibration method: D 2168-90 (96) (mechanical vs. manual) ___, other ___
4.2.3. Use circular or sector face rammer (mechanical rammer), sector: 4-in.: dia. 3.984-4.016-in. ___
4.3. Sample extruder (**optional, if split-type mold used**), jack, lever device, or other ___
4.4. Balance, 25-lb cap. sensitive to 0.01-lb ___ ; balance at least 1000-g cap. sensitive 0.1-g ___
4.5. Drying oven, 230 ± 9°F (110 ± 5°C) ___
4.6. Straightedge, rigid, steel, 12-in. long, one beveled edge ___
4.7. Sieves, 3-in., ¾-in., and No. 4 conforming to ASTM E 11 ___
4.8. Mixing Tools, mixing pan, trowel ___
4.9. Container, flat, round, approx. 12-in. dia. by 2-in. deep ___
4.10. Moisture Cans ___
4.11. Butcher knife, approx. 10-in. long ___

Procedure (soil passes No. 4):
5.2.1. Add soil and cement ___
5.2.2. Add water till 4 to 6 % below estimated opt. water content ___
5.2.3. Absorption time of 5 to 10-min. for heavy clays ___
5.2.5. Compact: 3 layers ___ ; 25 blows/layer ___ ; 12-in. height ___ ; uniform rigid foundation, 200-lb ___
5.2.6. Trim specimen and weigh ___
5.2.8. Take representative water content specimen, not < 100-g ___ ; oven-dry to constant mass ___

Report:
9.1.1. Optimum water content, % ___
9.1.2. Maximum density, pcf ___

Data sheet ___

S___F___N/A___

Wetting and Drying Compacted Soil-Cement
ASTM D 559-96

4.1. Mold, metal, 4-in.: dia. 3.984-4.016-in. (101.2- 102.0-mm) ___; vol. 0.0329-0.0337-ft^3 (933-955-cm^3) ___; collar, detachable, approx. 2.5-in. in height ___
4.2.1. and 4.2.2 Rammer (manual or mechanical) Free fall: 11.94-12.06-in. (303.2-306.4-mm) ___ ; wt. 5.48-5.52-lb (2.49-2.51-kg) ___ ; face dia. 1.99-2.01-in. (50.67-50.93-mm) ___ ; Guide sleeve with ≥ 4 vent holes ≥ 3/8-in. (9.5-mm) and 90° apart ___ ; centered at 0.6875-0.8125-in. (17.4-20.6-mm) from each end ___ ;
Mechanical Rammer, Calibration method: D 2168-90 (96) (mechanical vs. manual) ___, other ___
4.2.3. Use circular face rammer face (mechanical rammer) ___
4.3. Sample extruder (**optional, if split-type mold used**), jack, lever device, or other ___
4.4. Balance, 25-lb cap. sensitive to 0.01-lb ___ ; balance at least 1000-g cap. sensitive 0.1-g ___
4.5. Drying oven, 230 ± 9°F (110 ± 5°C) ___; drying oven, 160 ± 5°F (71 ± 3°C) ___
4.6. Moist Room, 70 ± 3°F (21 ± 1.7°C) ___; relative humidity of 100% ___
4.7. Water Bath for submerging specimens ___
4.8. Wire Scratch Brush, 2 by 1/16-in. flat No. 26 gage bristles in 50 groups of 10 bristles each (5 by 10) ___
4.9. Straightedge, rigid, steel, 12-in. long, one beveled edge ___
4.10. Sieves, 3-in., ¾-in., and No. 4 conforming to ASTM E 11 ___
4.11. Mixing Tools, mixing pan, trowel ___
4.12. Butcher knife, approx. 10-in. long ___
4.13. Scarifier, six-pronged ice pick or something similar ___
4.14. Container, flat, round, approx. 12-in. dia. by 2-in. deep ___
4.15. Measuring Device, such as calipers, readable to nearest 0.01-in. ___
4.16. Pans and Carriers ___
4.17. Graduated Cylinder, 250-mL cap. ___
4.18. Moisture Cans ___

Procedure (Soil passes No. 4 sieve):
5.1.1. Prepare in accordance with test method A of ASTM D 558 ___
5.1.2. Two compacted specimens and required moisture samples ___
5.1.3. Add cement ___
5.1.4. Add water ___
5.2.1. Compact soil-cement mixture in accordance with test method A of ASTM D 558 ___
5.2.2. Measure water content from representative sample ___
5.2.3. Weigh, dry specimen; calculate oven-dry weight ___
5.2.5. Form a second specimen; get % moisture and oven-dry weight ___
5.2.6. Determine average dia. and height of No. 1 specimen, calculate volume ___
5.2.7. Put specimens in moist room for 7-days ___
5.2.8. Weigh and measure No. 1 specimen at end of 7-days to calculate water content and volume ___
5.3.1. Submerge specimens in water at room temp. for 5-hr, remove ___ ;
Weigh and measure No. 1 specimen for moisture change, volume ___
5.3.2. Oven-dry both specimens at 160 ± 5°F (71 ± 3°C) for 42-hr and remove ___
Weigh and measure No. 1 specimen for moisture change, volume ___
5.3.3. Give specimen No. 2 two strokes with wire scratch brush ___
5.3.4. Repeat 5.3.1 to 5.3.3 for 12 cycles ___
5.3.6. Dry specimens to constant weight at 230 ± 9°F (110 ± 5°C), determine oven-dry weight ___

Report:
8.1.1. Designed optimum water content, and maximum density of molded specimens ___
8.1.2. Water content and density obtained in molded specimens ___
8.1.3. Designed cement content, %, of molded specimens ___
8.1.4. Maximum volume change, %, and maximum water content during test of specimen No. 1 ___
8.1.5. Soil-cement loss, %, of specimen No. 2 ___

Data sheet ___

S___F___N/A___

Freezing and Thawing Compacted Soil-Cement
ASTM D 560-96

4.1. Mold, metal, 4-in.: dia. 3.984-4.016-in. (101.2- 102.0-mm) ___; vol. 0.0329-0.0337-ft^3 (933-955-cm^3) ___ ; collar, detachable, approx. 2.5-in. in height ___
4.2.1. and 4.2.2 Rammer (manual or mechanical) Free fall: 11.94-12.06-in. (303.2-306.4-mm) ___ ; wt. 5.48-5.52-lb (2.49-2.51-kg) ___ ; face dia. 1.99-2.01-in. (50.67-50.93-mm) ___ ; Guide sleeve with ≥ 4 vent holes ≥ 3/8-in. (9.5-mm) and 90° apart ___ ; centered at 0.6875-0.8125-in. (17.4-20.6-mm) from each end ___ ;
Mechanical Rammer, Calibration method: D 2168-90 (96) (mechanical vs. manual) ___, other ___
4.2.3. Use circular face rammer face (mechanical rammer) ___
4.3. Sample extruder (**optional, if split-type mold used**), jack, lever device, or other ___
4.4. Balance, 25-lb cap. sensitive to 0.01-lb ___ ; balance at least 1000-g cap. sensitive 0.1-g ___
4.5. Drying oven, 230 ± 9°F (110 ± 5°C) ___
4.6. Freezing Cabinet, -10°F (-23°C) or lower ___
4.7. Moist Room, 70 ± 3°F (21 ± 1.7°C) ___ ; relative humidity of 100% ___
4.8. Wire Scratch Brush, 2 by 1/16-in. flat No. 26 gage bristles in 50 groups of 10 bristles each (5 by 10) ___
4.9. Straightedge, rigid, steel, 12-in. long, one beveled edge ___
4.10. Sieves, 3-in., ¾-in., and No. 4 conforming to ASTM E 11 ___
4.11. Mixing Tools, mixing pan, trowel ___
4.12. Butcher knife, approx. 10-in. long ___
4.13. Scarifier, six-pronged ice pick or something similar ___
4.14. Container, flat, round, approx. 12-in. dia. by 2-in. deep ___
4.15. Measuring Device, such as calipers, readable to nearest 0.01-in. ___
4.16. Pans and Carriers ___
4.17. Absorptive Pads, ¼-in. thick, felt pads, blotters, or similar ___
4.18. Graduated Cylinder, 250-mL cap. ___
4.19. Moisture Cans ___

Procedure (Soil passes No. 4 sieve):
5.1.1. Prepare in accordance with test method A of ASTM D 558 ___
5.1.2. Two compacted specimens and required moisture samples ___
5.1.3. Add cement ___
5.1.4. Add water ___
5.2.1. Compact soil-cement mixture in accordance with test method A of ASTM D 558 ___
5.2.2. Measure water content from representative sample ___
5.2.3. Weigh, dry specimen; calculate oven-dry weight ___
5.2.5. Form a second specimen; get % moisture and oven-dry weight ___
5.2.6. Determine average dia. and height of No. 1 specimen, calculate volume ___
5.2.7. Put specimens in moist room for 7-days ___
5.2.8. Weigh and measure No. 1 specimen at end of 7-days to calculate water content and volume ___
5.3.1. Put specimens with felt pads into freezing cabinet at -10°F (-23°C) for 24-hr, remove ___ ; Weigh and measure No. 1 specimen for moisture change, volume ___
5.3.2. Put specimens in moist room at 70 ± 3°F (21 ± 1.7°C) for 23-hr and remove ___ Weigh and measure No. 1 specimen for moisture change, volume ___
5.3.3. Give specimen No. 2 two strokes with wire scratch brush ___
5.3.5. Repeat 5.3.1 to 5.3.4 for 12 cycles ___
5.3.7. Dry specimens to constant weight at 230 ± 9°F (110 ± 5°C), determine oven-dry weight ___

Report:
8.1.1. Designed optimum water content, and maximum density of molded specimens ___
8.1.2. Water content and density obtained in molded specimens ___
8.1.3. Designed cement content, %, of molded specimens ___
8.1.4. Maximum volume change, %, and maximum water content during test of specimen No. 1 ___
8.1.5. Soil-cement loss, %, of specimen No. 2 ___

Data sheet ___

S___F___N/A___

Compaction - Standard Effort
ASTM D 698-00

6.1. Mold: (6 readings/top each 30°, 6 readings/bottom each 30°, 3 readings/height)
6.1.1. 4-in.: dia. 3.984-4.016-in. (101.2- 102.0-mm) ___, ht 4.566-4.602-in. (115.9-116.9-mm) ___, vol. 0.0328-0.0338-cu. ft. (930-958-cu cm) ___
6.1.2. 6-in.: dia. 5.974-6.026-in. (151.7-153.1-mm) ___, ht 4.566-4.602-in. (115.9-116.9-mm) ___, vol. 0.0741-0.0759-cu. ft. (2099-2149-cu cm) ___

6.2. Rammer (manual or mechanical):
Measuring device of suitable length for height of fall, measure to 0.01-in. ___
Free fall: 11.95-12.05-in. (303.5-306.1-mm) ___, wt. 5.48-5.52-lb (2.49-2.51-kg) ___, face dia. 1.99-2.01-in. (50.55-51.05-mm) ___
6.2.1. Guide sleeve with ≥ 4 vent holes at each end centered at 3/4 ± 1/16-in. (19.0 ± 1.6-mm) from end ___
6.2.1. Holes ≥ 3/8-in. (9.5-mmm) and 90° apart ___
6.2.2. Mechanical Rammer (circular face):
Clearance between rammer and inside, 0.10 ± 0.03-in. (2.5 ± 0.8-mm) ___
Calibration method: D 2168-90 (96) (mechanical vs. manual) ___, other ___
6.2.2.1. Sector face rammer: radius = 2.90 ± 0.02-in. (73.7 ± 0.5-mm) ___
6.3. Sample extruder **(Optional)** ___
6.4. Balance readable to 1-g ___
6.5. Drying oven, 230 ± 9°F (110 ± 5°C) ___
6.6. Stiff metal straight edge, ≥ 10-in. (254-mm), machined straight to tolerance of ± 0.005-in. (± 0.1-mm) ___
Beveled edge if > 1/8-in. (3-mm) thick ___
6.7. Sieves, 3/8-in., 3/4-in., and No. 4 sieves ___
10.4.2. Uniform Rigid Foundation with mold securing device, ≥ 200-lb concrete cylinder or cube ___

Apparatus for determining volume of mold:
A1.2.1.1. Vernier or Dial Caliper, 0 to 6-in. range readable to 0.001-in. ___
A1.2.1.2. Inside Micrometer (**optional, use only if Caliper not used**), 2 to 12-in. range readable to 0.001-in. ___
A1.2.1.3. Plastic or Glass Plates, 2 each, approx. 8-in. square by 0.25-in. thick ___
(if baseplate of mold is used, only one plate is required)
A1.2.1.4. Thermometer, 0 to 50°C range, 0.5°C gradations ___
A1.2.1.5. Stopcock grease ___
A1.2.1.6. Bulb syringe, towels, etc. ___

A1.4.1. Water-filling method ___
A1.4.2. Linear-measurement method ___
A1.5. Comparison of results (difference not > 0.5 % of nominal volume, use volume determined by water-filling method ___

Procedure: molds correct for particles tested:
1.3.1. Method A: 4-in. mold, material < No. 4, ≤ 20% retained on No. 4) ___ EM App. VI: 5% or less ___
1.3.1. Standard effort: 3-layers ___, 25-blows/layer ___
1.3.2. Method B: 4-in. mold (material < 3/8-in., > 20% retained on No. 4 & ≤ 20% retained on 3/8-in.) ___
1.3.2. Standard effort: 3-layers ___, 25-blows/layer ___
1.3.3. Method C: 6-in. mold (material < ¾-in., > 20% retained on 3/8-in. & < 30% retained on ¾-in.) ___
1.4. EM App. VI: material < ¾-in., > 5% retained on No. 4 ___, ≤ 5% retained on ¾-in. ___
1.3.3. Standard effort: 3-layers ___, 56-blows/layer ___
EM App. VI: 15-blow effort: same as standard effort except apply 15-blows per layer, no 6-in. mold ___

Calculation/Report (compaction curve with zero air voids curve, max. dry density, optimum water content) ___

Data forms (calculate of water contents & dry densities) ___

Data Sheet ___

S___F___N/A___

Specific Gravity
ASTM D 854-02

5.1. Pycnometer, stoppered flask, stoppered iodine flask, or volumetric flask, ≥ 250 ml capacity ___
5.1.1. If stoppered flask, label stopper to match flask ___
5.2. Balance readable to 0.01 g w/ 500 g capacity for 250 ml flask ___
Balance readable to 0.01 g w/ 1000 g capacity for 500 ml flask ___
5.3. Drying oven, 110 ± 5°C (230 ± 9°F) ___
5.4. Thermometer, readable to nearest 0.1°C, w/ immersion depth 25 – 80 mm (full immersion not allowed) ___
5.5. Desiccator, silica gel or anhydrous calcium sulfate ___
5.6. Air removal: hot plate ___, or vacuum ___
5.7. Insulated container, Styrofoam cooler & cover or equivalent to hold 3 – 6 pyncnometers + a beaker ___
5.8. Funnel, non-corrosive w/ stem extending past cal mark on vol. flask or stoppered seal on stoppered flask ___
5.9. Pycnometer filling tube w/ lateral vents (optional) ___
5.10. No. 4 sieve ___
5.11. Blender (optional) ___

6.1. Distilled or de-mineralized water ___

7.1. Specimen passing No. 4 sieve w/ recommended total spl size according to Table 1 ___
EM 1110-2-1906 App. IV: 50 to 80-g ___
8. Calibration of pyncnometer ___
8.1. Weigh clean dry pyncnometer to 0.01g, repeat 5 times, get avg. & std. dev. (std. dev. ≤ .02 g) ___
8.2. Fill w/ deaired water ___
8.3. Put pyncnometers in insulated container ___
8.4.1. Vol flask adjust water to cal. mark ___
8.4.2. Stoppered flask fill w/ water, put stopper in ___
8.5. Measure temp. of water to nearest 0.1°C ___
8.6. Repeat for 5 independent measurements on each pyncnometer ___
8.7. Compute calibrated volume for the 5 readings using formula 1 ___
8.8. Calculate avg. & std. dev. (std. dev. ≤ 0.05 ml) ___

9. Procedure:
9.3.1. Oven-dry specimen at 110 ± 5° C ___
9.3.2. Place funnel in pyncn., spoon soil into funnel rinsing soil adhering to funnel ___
9.3.3. Add water to 1/3 – ½ depth of main body, agitate until slurry is formed ___
9.5. Remove entrapped air by boiling, vacuum, or combination ___
9.5.1. Boil at least 2 hr. ___
9.5.2. Vacuum, continually agitate at least 2 hr. ___
9.5.3. Combination for at least 1 hr. ___
9.6. Fill pycnometer with distilled water to just below calibration marks and equilibrate ___
9.6.1. Stoppered iodine flask fill so base of stopper will be submerged, rest stopper at angle on neck ___
9.7. If heated, allow cooling to room temp. ___
9.8. Put in insulated container, therm. in beaker of water, close & let sit overnight ___
9.9.1. Vol. flask fill to cal. mark ___
9.9.2. Stoppered flask, put stopper in while removing excess water w/ eyedropper, dry flask ___
9.10. Weigh pycnometer, soil & water to 0.01 g using same balance used for calibration ___
9.11. Insert a thermometer into water and record temp to 0.1°C ___
9.12. Remove soil & dry @ 110 ± 5° C, weigh to 0.01 g ___

10. Calculation/Report (calculate specific gravity to nearest 0.01 (0.001 may be recorded) at 20°C) ___

Data Sheets ___

S___F___N/A___

Amount of Material Finer Than No. 200 Sieve (75-μm)
ASTM D 1140-00

5.1. Balance readable to 0.1% of test sample ___
5.2. Sieves (No. 200 and No. 40 or larger): ___
5.3. Oven to maintain 110 ± 5°C (230 ± 9°F) conforming to ASTM E 145-94 ___
5.4. Deflocculating agent, ~ 40-g/L **(optional)** ___

6.1. Sample in accordance with ASTM D 75-97 ___
6.2. Reduce sample in accordance with ASTM C 702-98: quarter ___, splitter ___

7.1. Dry to constant mass ___
7.2. Method A: wash sieving & dry ___
7.3. Method B: Alternative, particularly for very cohesive soils (soak w/ deflocculating agent ≥ 2 hr) ___
7.3.2. Procedure for determining percent fines (wash over No. 200, dry, & re-weigh) ___

Data forms (shows individual mass retained) ___

Data Sheet ___

S___F___N/A___

Density by Sand Cone
ASTM D 1556-00

6.1.1. Sand cone density apparatus (cone with jar attached) ___
6.1.3. Metal base plate, flanged, ≥ 3-in. (75-mm) larger than funnel ___
6.2. Sand: clean, dry, uniform, graded with $D_{60}/D_{10} < 2$ and max. size < 2-mm ; < 3% passing No. 60 sieve ___
Check sand density ≤ 14 days, before reusing, and each new batch ___
6.3. Balance readable to 5-g, ≥ 20-kg capacity ___

7. Procedure:
7.1.5. Min. test hole volumes (based on max. particle size):
½-in. (12.7-mm) max. particle size, 0.05-cu. ft. ___
1-in. (25.4-mm) max. particle size, 0.075-cu. ft. ___
1½-in. (38-mm) max. particle size, 0.1-cu. ft. ___
Dig hole through plate ___
7.1.6. Clean flange ___
Invert funnel ___
Open value ___
Close value after sand flow stops ___
7.1.7. Determine mass of apparatus ___
7.1.8. Determine mass of soil ___
7.1.10. Determine water content ___

Data forms (calculation of dry density & water content) ___

A1.2. Calibration of sand cone apparatus ___
A2.1. Calibration of density sand (container of known volume to 1%) ___

S___F___N/A___

Compaction - Modified Effort
ASTM D 1557-00

6.1. Mold: (6 readings/top each 30°, 6 readings/bottom each 30°, 3 readings/height)
6.1.1. 4-in.: dia. 3.984-4.016-in. (101.2- 102.0-mm) ___, ht 4.566-4.602-in. (115.9-116.9-mm) ___, vol. 0.0328-0.0338-cu. ft. (930-958-cu cm) ___
6.1.2. 6-in.: dia. 5.974-6.026-in. (151.7-153.1-mm) ___, ht 4.566-4.602-in. 115.9-116.9-mm) ___, vol. 0.0741-0.0759-cu. ft. (2099-2149-cu cm) ___

6.2. Rammer (manual or mechanical):
Measuring device of suitable length for height of fall, measure to 0.01-in. ___
Free fall: 17.95-18.05-in. (455.6-458.8-mm) ___, wt. 9.98-10.02-lb (4.53-4.55-kg) ___, face dia. 1.99-2.01-in. (50.55-51.05-mm) ___
6.2.1. Guide sleeve with ≥ 4 vent holes at each end centered at 3/4 ± 1/16-in. (19.0 ± 1.6-mm) from end ___
6.2.1. Holes ≥ 3/8-in. (9.5-mmm) and 90° apart ___
6.2.2. Mechanical Rammer (circular face):
Clearance between rammer and inside, 0.10 ± 0.03-in. (2.5 ± 0.8-mm) ___
Calibration method: D 2168-90 (96) (mechanical vs. manual) ___, other ___
6.2.2.1. Sector face rammer: radius = 2.90 ± 0.02-in. (73.7 ± 0.5-mm) ___
6.3. Sample extruder **(Optional)** ___
6.4. Balance readable to 1-g ___
6.5. Drying oven, 230 ± 9°F (110 ± 5°C) ___
6.6. Stiff metal straight edge, ≥ 10-in. (254-mm), machined straight to tolerance of ± 0.005-in. (± 0.1-mm) ___
Beveled edge if > 1/8-in. (3-mm) thick ___
6.7. Sieves, ¾-in., 3/8-in., and No. 4 sieves ___
10.4.2. Uniform Rigid Foundation with mold securing device, ≥ 200-lb concrete cylinder or cube ___

Apparatus for determining volume of mold:
A1.2.1.1. Vernier or Dial Caliper, 0 to 6-in. range readable to 0.001-in. ___
A1.2.1.2. Inside Micrometer (**optional, use only if Caliper not used**), 2 to 12-in. range readable to 0.001-in. ___
A1.2.1.3. Plastic or Glass Plates, 2 each, approx. 8-in. square by 0.25-in. thick ___
(if baseplate of mold is used, only one plate is required)
A1.2.1.4. Thermometer, 0 to 50°C range, 0.5°C gradations ___
A1.2.1.5. Stopcock grease ___
A1.2.1.6. Bulb syringe, towels, etc. ___

A1.4.1. Water-filling method ___
A1.4.2. Linear-measurement method ___
A1.5. Comparison of results (difference not > 0.5 % of nominal volume, use volume determined by water-filling method ___

Procedure: molds correct for particles tested:
1.3.1. Method A: 4-in. mold, material < No. 4, ≤ 20% retained on No. 4) ___ EM App. VI: 5% or less ___
1.3.1. Standard effort: 5-layers ___, 25-blows/layer ___
1.3.2. Method B: 4-in. mold (material < 3/8-in., > 20% retained on No. 4 & ≤ 20% retained on 3/8-in.) ___
1.3.2. Standard effort: 5-layers ___, 25-blows/layer ___
1.3.3. Method C: 6-in. mold (material < ¾-in., > 20% retained on 3/8-in. & < 30% retained on ¾-in.) ___
1.4. EM App. VI: material < ¾-in., > 5% retained on No. 4 ___, ≤ 5% retained on ¾-in. ___
1.3.3. Standard effort: 5-layers ___, 56-blows/layer ___
EM App. VI: 15-blow effort: same as standard effort except apply 15-blows per layer, no 6-in. mold ___

Calculation/Report (compaction curve with zero air voids curve, max. dry density, optimum water content) ___

Data forms (calculate of water contents & dry densities) ___

Data Sheet ___

S___F___N/A___

California Bearing Ratio (CBR)
ASTM D 1883-99

5.1. Loading machine:
Readable to 10 lbf (44 N) ___

Capacity: Max. CBR	Min. Capacity
20	2500-lbf (11.2-kN) ___
50	5000-lbf (22.3-kN) ___
>50	10,000-lbf (44.5-kN) ___

Load rate: 0.05-in/min (1.27-mm/min) ___
5.2. Mold:
Inside diameter: 5.974-6.026-in. (151.74-153.06-mm) ___
Height: 6.982-7.018-in. (177.34-178.26-mm) ___
Volume: 0.0741-0.0759-cu. ft. (2099-2149-cu cm) w/ spacer inserted ___
Extension collar: ≥ 2.0-in. (50.8-mm) ___
Metal base plate with 28 1/16-in. (1.59-mm) diameter holes ___
5.3. Spacer disk:
Min. outside diameter: 5 15/16-in. (150.8-mm) ___
Height: 2.411-2.421-in. (61.243-61.497-mm) ___
5.4. Rammer: (As specified in ASTM D 698-91 (98) and D 1557-91 (98)
Four vent holes at each end with centers at 11/16 – 13/16-in. (17.4-20.6-mm) from end ___
90° apart ___
Minimum diameter of 3/8-in. (9.5-mm) ___
Standard type:
Height of fall: 11.95-12.05-in. (303.5-306.1-mm) ___
Mass: 5.48-5.52-lb (2.490-2.510-kg) ___
Face diameter: 1.99-2.01-in. (50.55-51.05-mm) ___
Modified type:
Height of fall: 17.95-18.05-in. (455.6-458.8-mm) ___
Mass: 9.98-10.02-lb (4.530-4.550-kg) ___
Face diameter: 1.99-2.01-in. (50.55-51.05-mm) ___
5.5. Expansion-Measuring Device:
Diameter: 5 7/8 – 5 15/16-in. (149.23 – 150.81-mm) ___
≥ 42 1/16-in. (1.59-mm) holes ___
5.6. Annular weights:
Mass: 4.52-4.56-kg ___
Diameter: 5 7/8 – 5 15/16-in. (149.23 – 150.81-mm) ___
Center hole diameter is about 2 1/8-in. (53.98-mm) ___
Slotted weights: 2.25-2.29-kg ___
5.7. Penetration piston:
Diameter - 1.949-1.959 in. (49.50 – 49.76 mm) ___
Length: ≥ 4-in. (101.6-mm) ___
5.8. Gages: dial gages readable to 0.001-in. (0.025-mm) ___
5.9. Miscellaneous equipment:
Straight edge ___, mixing tools/containers ___; 2-in., ¾-in. and #4 sieves ___,
CBR soaking tank ___, filter paper ___, oven ___
7. Uniform Rigid Foundation with mold securing device, ≥ 200-lb concrete cylinder or cube ___
Procedure: molds correct for particles tested:
6-in. mold (material < ¾-in.) ___
EM App. VI: material < ¾-in., > 5% retained on No. 4 ___, ≤ 5% retained on ¾-in. ___
Standard effort: 3-layers ___, 56-blows/layer ___
Modified effort: 5-layers ___, 56-blows/layer ___
EM App. VI: 15-blow effort: same as standard effort except apply 15-blows/layer, no 6-in. mold ___

Data forms (calculate of water contents & dry densities) ___, CBR load and penetration data ___
Calc./Report (compaction curve with zero air voids curve, max. dry density, optimum water content) ___
CBR plot of stress on piston (psi) vs. penetration (in.) ___, calculate CBR (%) ___

S___F___N/A___

Unconfined Compressive Strength
ASTM D 2166-00

5.1. Compression device:
For load < 100-kPa (1-tsf) strength, tolerance of 1-kPa (0.01-tsf) ___
For load ≥ 100-kPa (1-tsf) strength, tolerance of 5-kPa (0.05-tsf) ___
5.2. Sample extruder ___
5.3. Deformation indicator
Readable to 0.03-mm (0.001-in.), travel ≥ 20% of length of test specimen ___
5.4. Dial comparator within 0.1% of measured dimension ___
5.5. Timer to nearest second ___
5.6. Balance readable to 0.1% of total mass ___
5.7. Equipment specified in C 2216 ___
5.8. Miscellaneous apparatus:
Oven 110 ± 5°C ___, trimming frame ___, carving tools ___,
remolding apparatus (mold and tamper) ___

6.1. Specimen size ___
3 height measured 120° apart ___
3 diameter measured at quarter points ___
Specimen height to diameter ratio of 2 to 2.5 ___
EM 1110-2-1906 App. XI (not < 2.1) ___
7.1. Strain rate (0.5 to 2%/min.) ___
EM 1110-2-1906 App. XI (1%/min. or slower for stiff soils) ___
7.2. Failure sketch or photo ___

8. Calculation/Report (stress vs. strain plot, if desired) ___

Data Sheet ___

S___F___N/A___

Density by Rubber Balloon
ASTM D 2167-94 (01)

5.1. Balloon apparatus ___
5.2. Base plate, rigid (min. dimension 2 times test hole diameter) ___
5.3. Balance readable to 5.0-g, ≥ 20-kg capacity ___
5.4. Drying apparatus, oven ___
5.5. Miscellaneous equipment ___
Trowel, brush, buckets, plastic bags

6.1. Calibration ___

7. Procedure:
7.1. Prepare surface ___
Assemble base plate and rubber balloon ___
Dig hole ___
Min. test hole vol. Based on max particle size:
½-in. (12.5-mm) 0.05-cu ft ___
1-in. (25.0-mm) 0.075-cu ft ___
1½-in. (37.5-mm) 0.1-cu. ft.) ___

Calculation/Report ___

Data Sheet ___

S___F___N/A___

Calibration of Laboratory Mechanical-Rammer Soil Compactors
ASTM D 2168-02

4. Apparatus:
4.1. Method A, apparatus in D 698 & D 1557, the following ___
4.2. Method B in addition to apparatus in D 698 & D 1557, the following;
4.2.1. Lead deformation apparatus – anvil, guide collar, & striking pin as Fig. 1 ___
4.2.2. Caliper – readable to 0.001 in (0.02mm) or dial comparator ___
4.2.3. Guide sleeve pedestal – to control drop of manual rammer as Fig. 3 ___
4.2.4. Lead test cylinders – 0.0675 ± 0.005 in. (17.1 ± 0.1mm) long ___
Diameter of 0.310 ± 0.002 in. (7.87 ± 0.05 mm) __
Lightest w/in 0.06g of heaviest, minimum of ten ___

5. Procedure – Method A:
5.2. 50 lb (23 kg) CL soil & prepare in accordance w/ D 698 or D 1557 ___
5.3. Perform curve to get γ_{max} to D698 or D 1557 w/ manual & mechanical compactor ___
5.4. Get % diff. (W) of γ_{max}, if absolute value of W ≤ 2.0, mechanical rammer ready for use ___
Determine $\overline{W}$, the avg. % diff. of γ_{max} values for 3 sets of data ___
If $\overline{W}$ is ≤ 2.0, mechanical rammer ready for use ___
If $\overline{W}$ > 2.0 get 2 additional sets, if still > 2.0, adjust rammer weight to 5.5, get 3 new values ___
Repeat until $\overline{W}$ ≤ 2.0 ___
5.5. Adjust wt. of rammer but not > 10 % of original wt. ___

6. Procedure – Method B:
6.2. Deformation by manual compactor:
6.2.1. Select set of 5 cylinders & remove burrs ___
6.2.2. Get initial measurements, C_1, according to 6.2.5 ___
6.2.3. Assemble def apparatus w/ lead cylinder & apply 1 drop w/ manual compactor ___
6.2.4. Get measurements, C_2, according to 6.2.5, diff. between C_1 & C_2 = D ___
6.2.5. Get difference C_1 & C_2 = D, either by:
6.2.5.1. Measure length of cylinder ___
6.2.5.2. Get measurement of assembled apparatus, in dial comp so that top center of the ¼-in. steel ball of striking pin is directly under the top of the dial stem ___
6.2.6. Repeat 6.2.2 – 6.2.5 for 5 unused cylinders until 5 def not vary > 2.0 % from $\overline{D}$, the avg. value, that is, the absolute value of V_1 must be < 2.0 for the 5 values (7.2), def. Value for manual rammer is $\overline{D}$ ___
6.3. Deformation by mechanical compactor:
6.3.1. Select set of 5 cylinders & remove burrs ___
6.3.2. Assemble def apparatus w/ lead cylinder & apply 1 drop w/ mechanical compactor ___
6.3.3. Get avg. def value $\overline{D}'$ using same procedure in 6.2, except don't use guide sleeve pedestal ___
6.3.4. Repeat 6.3.2 & 6.3.3 on rest of cylinders in set ___
6.4. Calculate V_2, the % diff of avg. def value, if V_2 not vary > ±2.0, mech. compactor ready for use ___
6.5. If V_2 > ±2.0, repeat 6.3.2 & 6.3.3 for 2 more values of V_2 ___
Avg. absolute values of all 3 V_2'S, if avg. ≤ 2.0, mech. compactor ready for use ___
If > 2.0, adjust wt. of mech. rammer to 5.5 ___
Get additional sets of data until mean value of V_2 for the3 sets of data ≤ 2.0 ___

7. Calculation ___

8. Report ___

Data Sheet ___

S___F___N/A___

Water Content

ASTM D 2216-98

6.1. Drying oven, 110 ± 5°C ___
6.2. Balance conforming to ASTM D 4753-95:
≤ 200-g, readable to 0.01-g ___
> 200-g, readable to 0.1-g ___
6.3. Sample container
≤ 200-g sample, non-corroding durable containers with either close-fitting lids or dessicator ___
> 200-g sample, open containers, no lids required ___
6.4. Desiccator (**optional, use only if no close fitting lids**), silica gel or anhydrous calcium sulfate ___
6.5. Container handling apparatus, gloves or tongs ___

8.2. Specimen size based on maximum particle size:

Max. particle size	Min. mass, ± 0.1%	Min. mass, ± 1%
2-mm (No. 10)	20-g ___	20-g ___
4.75-mm (No. 4)	100-g ___	20-g ___
9.5-mm (3/8-in.)	500-g ___	50-g ___
19.0-mm (¾-in.)	2.5-kg ___	250-g ___
37.5-mm (1 ½-in.)	10-kg ___	1-kg ___
75.0-mm (3-in.)	50-kg	5-kg

10.1. Determine tare mass ___
10.3. Determine container and sample mass ___
10.4. Dry to a constant mass, 12 to 16-hr. for soils other than sands & gravels) ___
10.5. Determine mass promptly upon cooling ___

11. Calculate water contents, wet mass, dry mass, & tare mass ___

Data Sheets ___

S___F___N/A___

Wet Preparation of Soil Samples for Particle -Size Analysis
ASTM D 2217-85 (98)

4.1. Balance sensitive to 0.1-g ___
4.2. Mortar and rubber-covered pestle ___
4.3. Sieves, No. 10 and No. 40 ___
4.4. Sampler or splitter ___
4.5. Drying apparatus, oven @ 140°F (60°C) and 230°F (110°C) ___
4.6. Filter funnel or candles **(Optional)** ___
4.7. Miscellaneous equipment ___
Pans (12-in. diam. 3-in. deep) ___

Data Sheet ___

S___F___N/A___

Permeability of Granular Soils (Constant Head)
(permeability of soil greater than 1 x 10^{-3}-cm/s)
ASTM D 2434-68 (00)

4.1. Permeameter with porous disks conforming to 6.1 ___
4.2. Filter Tank with valve ___
4.6. Manometer Tubes ___

4.5. Supporting equipment ___
Funnels ___, specimen compaction equipment (tamper) ___, vacuum pump ___,
balance readable to 1-g, 2-kg capacity ___, scoop ___, thermometer ___, 250-ml graduate ___

6. Preparation:
6.1. Correct cylinder diameter size of permeameter ___
Max. particle size between No. 10 and 3/8-in.:
< 35% soil retained on No. 10 (use 3-in. diameter cylinder) ___
> 35% soil retained on No. 10 (use 4.5-in. diameter cylinder) ___
Max. particle size between 3/8-in. and ¾-in.:
< 35% soil retained on 3/8-in. (use 6-in. cylinder diameter.) ___
> 35% soil retained on 3/8-in. (use 9-in. cylinder diameter.) ___

7.1. Measure and record:
Time ___
Head ___
Quantity of flow ___
Water temperature ___

8. Calculation/Report (calculate coefficient of permeability in cm/s, corrected to 20^{o} C) ___

Data Sheet __

S___F___N/A___

One Dimensional Consolidation
ASTM D 2435-96

6.1. Load device accurate to ± 0.5% of applied load ___
6.2. Consolidometer ___
6.2.1. and 6.2.2. Specimen ring, 2-in. min. specimen diameter by 0.5-in. min. height ___
6.3. Porous disks, clean and free from cracks or chips ___
6.4. Trimming device ___
6.5. Deformation indicator readable to 0.0001-in. ___
6.6. Supporting equipment ___
Balance ___, and containers ___ per ASTM D 2216; timing device ___;
distilled or de-mineralized water ___, spatulas ___; knives ___; wire saws ___
6.7. Balance conforming to ASTM D 4753-95:
≤ 200-g, readable to 0.01-g ___
> 200-g, readable to 0.1-g ___
6.8. Drying oven, 110 ± 5°C ___
6.9. Sample container
≤ 200-g sample, non-corroding durable containers with either close-fitting lids or dessicator ___
> 200-g sample, open containers, no lids required ___
6.10. Environment – Temperature fluctuations less than ± 4°C (± 7°F) ___

8. Calibration, vert. Deformations corrected for apparatus flexibility (8.1 – 8.4) ___

11. Procedure:
Seating load (0.05-tsf) ___, EM 1110-2-1906 App. VIII (0.01-tsf) ___
11.5.1. Load increment cycle (0.125-, 0.25-, 0.5, 1-, 2-, 4-tsf, etc.) ___
11.5.1. Method A (load increments of 24 hr. or multiples, time vs. deform. on min. of 2 loads) ___
11.5.2. Method B (time vs. deform. on all loads, successive loads applied after 100% primary cons.) ___

12. Calculation/Report (time vs. deform. plots, void ratio vs. pressure plot) ___

Data Sheet ___

S___F___ N/A___

Classification of Soils (USCS)
ASTM D 2487-00

Unified Soil Classification System (USCS) Procedure, follow classification charts for identifying soil ___

Corps of Engineers Procedure, follow classification charts for identifying soil as found in:
US Army Engineer Waterways Experiment Station, ~~The Unified Soil Classified System~~,
Technical Memorandum No. 3-357, Vol 1 ___

Data forms (use percent gravel, sand, fines & liquid and plastic limits to classify soil) ___

S___F___ N/A___

Description and Identification of Soils (Visual-Manual)
ASTM D 2488-00

Visual Procedure: describe soil based on:
10.1. Angularity (angular, subangular, subrounded, rounded) ___
10.2. Shape (flat, elongated, flat & elongated) ___
10.3. Color ___
10.4. Odor (organic, oil product, chemical) ___
10.5. Moisture condition (dry, moist, wet) ___
10.6. HCl reaction (none, weak, strong) ___
10.7. Consistency (very soft, soft, firm, hard, very hard) ___
10.8. Cementation (weak, moderate, strong) ___
10.9. Structure (stratified, laminated, fissured, slickensided, blocky, lensed, homogeneous) ___
10.10. Particle sizes (range of particle sizes, max. particle size, sand, gravel, cobble) ___
10.11. Maximum particle size (sand – fine, Med., or coarse)(gravel – smallest sieve pass)(cobble or boulder) ___
10.12. Hardness (fracture, crumble, or hard) ___
14.2. Dry strength (none, low, medium, high, very high) ___
14.3. Dilatancy (none, slow, rapid) ___
14.4. Toughness (low, medium, high) ___
14.5. Plasticity (nonplastic, low, medium, high) ___

Data forms (description of soil parameters) ___

S___F___N/A___

Unconsolidated Undrained Triaxial Compression (Q-Test)
ASTM D 2850-95 (99)

5.1. Axial loading device accurate to ± 5% of selected value ___
5.2. Axial load-measuring device accurate to 1% of axial load at failure (load ring/load cell) ___
5.3. Triaxial compression chamber ___
5.4. Axial load piston ___
5.5. Pressure-control device capable of applying pressure to ± 0.25-psi for pressures less than 28-psi and to within ± 1% for pressures greater than 28-psi ___
5.6. Specimen cap and base ___
5.7. Deformation indicator accurate to 0.03% of specimen height and range of at least 20% of specimen height (dial indicator, linear variable differential transformer (LVDT)) ___
5.8. Rubber membrane and O-rings ___
5.9. Sample extruder ___
5.10. Specimen size measurement device accurate to 0.1% (pi tape, calipers) ___
5.11. Timer to 1 sec ___
5.12. Balances to 0.1 % test mass or better ___
5.13. Supporting equipment ___
Balance to 0.1% of test mass ___, oven ___, and containers ___ per ASTM D 2216, timing device ___; trimming device ___; knives ___; wire saws ___; steel straightedge ___, miter box ___, mold and tamper for compacting specimens ___

6. Test specimens:
6.1. Specimen height to diameter ratio of 2 to 2.5 ___; EM 1110-2-1906 App. XI (not < 2.1) ___
6.2. 3 height measured 120° apart ___; 3 diameter measured at quarter points ___

7. Procedure:
7.5. Strain rate used (0.3%/min.-brittle soils to 1%/min.-plastic soils) ___
7.5. Time to failure about 15 to 20 minutes ___
7.8. Failure sketch ___

8. Calculation/Report (stress vs. strain plot, Mohr circles plot) ___

Data Sheet ___

S___F___ N/A___

Density by Nuclear Methods
ASTM D 2922-01

5.1. Nuclear gage ___
5.2. Reference standard (block) ___
5.3. Site preparation device, plate, straightedge ___
5.4. Drive pin, larger than rod ___
5.5. Drive pin extractor ___
6.2. Film badges ___ ; Leak tests ___
8.2. Standardization check (take readings to compare against previous readings) ___
8.2. Permanent record ___

9.3. Remove loose and disturbed material ___
9.4. Plane a smooth surface
Fill voids between ground surface and gage, use fine sand ___
9.5.2.1. Make hole using guide plate and drive pin ___
Guide plate same size as gage ___
Score the soil around guide plate ___
9.5.2.6. Gently pull gage so probe is against side of the hole ___

7. Calibration:
7.1. Calibration in accordance with Annex A1 ___,
A1.1. Verify or calibrate every ≤ 24 months, and after major repair ___

Operator safety training (manufacturer or in-house) ___

Data Sheets ___

S___F___N/A___

Density by Drive Cylinder
ASTM D 2937-00

5.1. Drive cylinders:
Diameter, 4 to 6-in. (75 to 140-mm) or larger ___
5.2. Drive head with sliding weight ___
5.3. Straightedge, 1/8 by 1½ by 12-in., sharpened 45° edge ___
5.4. Shovel ___
5.5. Balance readable to 1-g ___
5.6. Drying equipment, oven ___
5.7. Miscellaneous equipment ___
Hammer ___; brush ___; metal cans with lids ___; caliper accurate to 0.01-in. ___

7.1.1. Calibration: means of calibrating cylinders (vol. to 0.01-cu. in.) ___

9.2. Calculation: Water Content, % ___
9.3. Calculation: Dry Density, lb/ft^3 ___

Data Sheet ___

S___F___ N/A___

Water Content by Nuclear Methods
ASTM D 3017-01

5.1. Nuclear gage ___
5.1.5. Reference standard (block) ___
5.1.6. Site preparation device, plate, straightedge ___
5.2. Calibrate once each year in accordance with Annex A1 ___
A1.1. Verify or calibrate every ≤ 24 months, and after major repair ___
5.3. Determine precision of apparatus in accordance with Annex A2 ___
6.2. Film badges ___; Leak tests ___
7.2. Standardization check (take readings to compare against previous readings) ___
7.2. Permanent record ___

8.3.1. Remove loose & disturbed material ___
8.3.2. Plane a smooth surface
Fill voids between ground surface & gage, use fine sand ___

8.4.1. Seat gage firmly, place source in proper location, take count for normal measurement period ___
8.4.2. Determine ratio of reading to standard count ___
From this ratio, calibration, & adjustment data determine in-place water content per unit volume ___

9. Calculation:
9.1. Calculate water content as follows:
9.1. $w = M_m \times 100/\rho_d$ or $w = M_m \times 100/p - M_m$
where:
w = water cont, % of dry density,
M_m = water content, kg/m^3 (lb/ft^3),
ρ_d = dry density, kg/m^3 (lb/ft^3), and
ρ = wet (total) density, kg/m^3 (lb/ft^3).

10. Report ___
Operator safety training (manufacturer or in-house) ___

Data Sheets ___

S___F___N/A___

Direct Shear of Soils under Consolidated Drained Conditions
ASTM D 3080-98

6.1. Shear device ___
6.2. Shear box (circular or square drained top and bottom) ___
6.3. Porous inserts ___
6.4.1. Device for applying and measuring normal force to within ± 1% of specified load ___
6.4.2. Device for shearing the specimen with uniform rate of displacement (± 5% deviation) with a range of 0.0001 to 0.04-in./min. ___
6.5. Device for measuring shear force (proving ring, load cell) accurate to 0.5-lb. or 1% of shear force at failure whichever is greater ___
6.6. Shear box bowl ___
6.8. Trimming device or cutting ring ___
6.10. Deformation indicator (dial gages or displacement transformers able to measure the change of thickness of the specimen to 0.0001-in. and to measure horizontal displacement to 0.001-in.) ___
6.11. Oven and containers per ASTM D 2216 ___
6.13. Supporting equipment ___
Balance ___, timing device ___; distilled or de-mineralized water ___, knives ___; wire saws ___; steel straightedge ___, mold & tamper for compacting specimens ___

8. Calibration, vert. Deformations corrected for apparatus flexibility (8.1 – 8.5) ___

9. Procedure ___
7.2. Minimum specimen diameter or width of 2.0-in. ___
7.3. Minimum specimen thickness of 0.5-in. ___
7.4. Minimum specimen diameter to thickness or width ratio of 2:1 ___
9.1.2.1. Strain rate used (based on t50, time to failure = 50 times t50) ___

Calculation/Report (shear stress vs. horizontal deformation plot, normal stress vs. shear stress plot, vertical deformation vs. horizontal deformation plot) ___

Data Sheet ___

S___F___N/A___

Preserving and Transporting Soil Samples
ASTM D 4220-00

6.1.1. Sealing wax ___
6.1.2. Metal disks, 2 mm thick ___
6.1.3. Wood disks, prewaxed, 1-in. (25 mm) thick ___
6.1.4. Tape (waterproof plastic, adhesive, or duct) ___
6.1.5. Cheesecloth ___
6.1.6. Caps: plastic ___, rubber ___, metal ___
6.1.7. O-rings (Sealing End Caps) for sealing ends of samples ___
6.1.8. Jars, wide-mouth ____
6.1.9. Bags, plastic ___, burlap w/ liner ___, burlap or cloth ___
6.1.10. Packing material ___
6.1.11. Insulation, granule (bead) ___, sheet ___, or foam ___
6.1.12. Sample cube boxes (0.5-in to 0.75-in. plywood) ___
6.1.13. Cylindrical sample container ___
6.1.14. Shipping containers, box ___, or cylindrical ___
6.1.15. Identification material (pens, tags, and labels) ___

Data Sheets ___

S___F___ N/A___

Maximum Index Density by Vibratory Table
ASTM D 4253-00

6.1.1. Standard molds; 6-in. dia. (+ 0.005-in.) ___, ht. (6.112 + 0.005-in.) ___, in-use vol. (0.1 ± 0.0015-cu. ft.) ___;
11-in. diameter (+ 0.005-in.) ___, height (9.092 + 0.005 in.) ___, in-use vol. (0.5 ± 0.0075-cu. ft.) ___
6.1.3. Guide sleeves; one for each size mold ___
6.1.4. Surcharge base plates; one for each size mold, 0.5 in. thick ___
6.1.5. Surcharge weights for 2.0 ± 0.02-psi pressure for each mold ___
6.1.6 Surcharge base plate handle; to initially place & remove base plate ___
6.2. Dial-indicator gage holder & dial indicator; ≥ 2-in. travel, readable to 0.001-in. ___
6.3. Balances readable to 0.1 % ___
6.5. Drying oven, 110 ± 5°C (230 ± 9°F) ___
6.6. Sieves, 3-in., 1 ½-in., ¾-in., 3/8-in., No. 4, & No. 200 ___
6.7. Calibration bar, 3 x 12 x ¼-in. **(Optional)** ___
6.8. Brush ___; pans ___; straight edge ___; scoops ___
6.9. Vibrating table ___

10.5. Vibrating table double amplitude of vibration of 0.013 ± 0.002-in. at 60-Hz or 0.019 ± 0.003-in. at 50-Hz ___
Double amplitude of vibration on the mold measured to nearest 0.0005-in. ___
Method for optimum double amplitude of vibration based on peak density obtained from about 4 trials with the double amplitude of vibration varying from about 0.008 to 0.025-in. ___
EM 1110-2-1906 App. XII: trials performed with rheostat settings varied from 0 to 100 in increments of 10, measurements taken after each period of vibration, use rheostat setting producing peak density ___

11. Procedure:
11.1.2. Maximum density (minimum density required in accordance w/ D 4254):
Place sand into mold and level the surface ___
11.1.3. Place base plate on soil ___
11.1.4. Attach mold to vibrating table ___
11.1.5. Attach guide sleeve & lower surcharge onto base plate ___
11.1.7. Vibrate 8 ± ¼ min. @ 60 ± 2 Hz, or 12 ± ¼ min. @ 50 ± 2 Hz ___
11.1.8. Get dial rdgs. opposite sides of base plate ___
11.1.9. Remove assembly form mold ___
11.1.10. Weigh mold & soil & calculate max. density as in paragraph 12 ___
11.1.11. Repeat 11.1.11 – 11.1.10 until values w/in 2 % ___

Data forms ___

Calculation/Report (calculate of minimum, maximum, and relative density if field density known) ___

S___F___ N/A___

Minimum Index Density
ASTM D 4254-00

6.1.1. Drying oven, 110 ± 5°C (230 ± 9°F) ___
6.1.2. Sieves, 3-in., 1 ½-in., ¾-in., 3/8-in., No. 4, & No. 200 ___
6.3. Apparatus for test methods A & B:
6.3.1. Standard molds; 6-in. dia. (+ 0.005-in.) ___, ht. (6.112 + 0.005-in.) ___, in-use vol. (0.1 ± 0.0015-cu. ft.) ___; 11-in. diameter (+ 0.005-in.) ___, height (9.092 + 0.005 in.) ___, in-use vol. (0.5 ± 0.0075-cu. ft.) ___
6.3.3. Balances readable to 0.1 % ___
6.3.4. Pouring devices; Used with 0.1-cu. ft. mold having 1.25 to 2 times greater than volume of mold and having spouts about 6-in. long; two spouts required (0.5-in. diameter and 1.0-in. diameter) ___
6.3.5. Rigid thin-walled tubes (method B) ___
6.3.6. Brush ___; pans ___; straight edge ___; scoops ___
6.4. Apparatus for test method C:
6.4.1. Glass graduated cylinder, 2000 ml graduated to 20 ml ___
6.4.3. Sieves, 3/8-in. & No. 200 ___

9. Procedure method A:
9.2.2. Pour sand into mold with spiral motion at ½-in. fall to about 1/2 to 1-in. above top of mold ___
9.2.2.1. Fill to about 1/2 to 1-in. above top of mold ___
9.2.2.2. Screed excess off top carefully (avoid jarring or disturb soil) even w/ top of mold ___
9.2.4. Weigh mold & soil ___
9.2.5. Repeat trials until minimum densities are within 1% of each other ___
9.3. Method B:
9.3.3. Place rigid thin-walled tube inside of mold, fill tube with sand to within 1/8 to ¼-in. of top of mold ___
9.3.4. Raise tube to overfill mold ___
9.3.5. Trim excess soil ___
9.3.6. Weigh mold & soil ___
9.3.7. Repeat trials until minimum densities are within 1% of each other ___
9.4. Method C:
9.4.1. Place 1000 ± 1-g sand in graduated cylinder, place stopper, tip upside down & return to vertical position ___
9.4.2. Record the volume of the graduated cylinder the sand occupies ___
9.4.3. Repeat trials until minimum densities are within 1% of each other ___

Data forms ___

Calculation/Report (calculate of minimum, maximum, and relative density if field density known) ___
Maximum density:

S___F___N/A___

Liquid & Plastic Limits (Atterberg Limits)
ASTM D 4318-00

6.1. Liquid Limit Device:
6.1.1. Base, hard rubber:
D-durometer hardness of 80 to 90 ___
Resilience rebound of 77 to 90% (7.577 to 8.856-in.) (19.25 to 22.50-cm) ___
EM 1110-2-1906 App. III: 80 to 90% rebound (7.872 to 8.856-in.) ___
6.1.2. Rubber feet hardness, A-durometer ≤ 60 (feet attached to base) ___
6.1.3. Cup, brass; mass including hanger of 185 to 215-g ___
6.1.4. Cam, 180 degree of cam rotation ___
6.1.5. Carriage, removable pin ___
6.1.6. Motor drive, 2 ± 0.1-revolutions per second ___
6.2. Flat Grooving tool:
Plastic or non-corroding metal ___
Tip width of 1.9-2.1-mm ___
Depth of tip of 7.9-8.1-mm ___
6.3. Gage block, 50-mm by 25-mm by 9.95-10.05-mm (0.392-0.396-in.) ___
Edge of gage block, ≥ 10-mm (3/8-in.) wide ___
6.4. Specimen containers (2-in. diameter. by 1-in. high with snug fitting lids) ___
6.5. Balance readable to 0.01-g and accurate to 0.02-g ___
6.6. Storage containers, porcelain, glass, or plastic dish ___
6.7. Plastic Limit:
6.7.1. Ground glass plate, ≥ 30-mm (12-in.) square, 1-cm (3/8-in.) thick ___
6.7.2. Plastic limit rolling device (**optional**) ___ ; 6.8 Spatula ___ ; 6.9 Sieve, No. 40 ___
6.10 Wash bottle ___ ; 6.11 Drying oven 110 ± 5°C ___ ; 6.12 Washing pan ___

9.1.1.1. Wear of base, spot ≤ 10-mm ___
9.1.1.2. Wear of cup, ≥ 0.1-mm (0.004-in.) groove ___
9.1.1.3. Wear of cup hanger, pivot does not bind, no side to side movement > 3-mm (1/8-in) ___
9.1.1.4. Wear of cam, not worn to lose contact ___
9.1.2. Grooving tool inspect frequently ___
9.2. Height of drop, 10 ± 0.2-mm drop height ___

10.0. Sample preparation:
10.1. Wet preparation required except when dry method is specified ___
10.1.1.1. Distilled or de-mineralized water ___

11.0. Multipoint Liquid Limit Procedure:
10.1.2.4. Prepare slurry for 25 to 35-blows (dry to wet method) ___, Overnight (16-hr.) curing ___
EM 1110-2-1906 App. III: prepare slurry for 15 to 25-blows (wet to dry method) ___
11.1. Adequate amount of material in cup (10-mm at deepest point) ___
11.3. Drop rate of 19 to 21-drops/10-sec. ___, closure of 0.5-in. (13 mm) ___
11.7. Blows for LL range 15 – 35 blows ___
13.0. One-point Liquid Limit Procedure:
13.1. 20 – 30 blows to closure ___
13.2. Duplicate trials – second trial no more than 2 blows different from first trial ___

16.0. Plastic limit procedure:
16.1. 20-g mass, select 1.5 to 2.0-g for initial specimen ___
16.3. Threads of proper dimensions 3.2-mm (1/8-in.) diameter by 3.2-9.5-mm (1/8 to 3/8-in.) long ___
16.5. Specimen mass (≥ 6-g per trial) ___; EM 1110-2-1906 App. III: specimen mass (≥ 9-g per trial) ___
16.6. Duplicate trials ___
18.0 Calculation: Plasticity Index PI (whole no.) = LL (whole no.) – PL (whole no.) ___
Data forms (calculate of water contents, plot of No. of blows vs. water content for liquid limit) ___

19.1.4. Report: report LL, PL, and PI to nearest whole number ___

S___F___N/A___

One-Dimensional Swell or Settlement Potential
ASTM D 4546-96

7. Apparatus & materials:
7.1. Consolidometer ___
7.2. Porous stones, smooth ground, fine enough to minimize intrusion of soil ___
7.2.1. Porous stones shall be air dry ___
7.2.2. Porous stones fit close to consolidometer ring ___
7.3. Plastic membrane, aluminum foil, or moist towel ___

9. Specimen preparation:
9.1. Undisturbed or lab-compacted specimens ___
9.2. Trim in accordance w/ D 2435 ___
Supporting equipment ___
Balance ___, oven ___, trimming device ___, and containers ___ per ASTM D 2216, timing device ___, distilled or de-mineralized water ___, spatulas ___, knives ___, wire saws ___, deformation indicator to 0.0001-in. ___

10. Calibration:
10.1. Calibrate consolidation machine in accordance w/ D 2435 ___
10.2. Measure compressibility of apparatus ___

11. Procedure:
12.1. Assemble apparatus w/ soil specimen in place ___
12.2. Apply seating load 1 kPa (20 lb/ft^2) ___
12.3.2. Method A, inundate specimen and record readings until swell complete, apply vertical pressure until specimen recompressed to initial void ratio / height ___
12.3.3. Method B, apply vertical pressure, record deformation, inundate specimen, and record readings until swell complete, apply vertical pressure until specimen recompressed to initial void ratio / height ___
12.3.4. Method C, apply initial stress, record deformation, inundate specimen, and apply vertical stress as needed to prevent swell ___

13. Calculation ___

14. Report ___

Data Sheet ___

S___F___N/A___

Density of Soil in Place by the Sleeve Method
ASTM D 4564-02

6. Apparatus:
6.1. Sleeve apparatus (sleeve, sleeve base plate, measurement plate, and driver) ___
6.2. Balance with min. capacity of 1000-g and a 0.1-g read conforming to ASTM D 4753-95 ___
6.3. Oven as required by ASTM D 2216 ___
6.4. Miscellaneous equipment, shovel ___, hammer ___, nails ___, scoops ___, spoons ___, buckets w/ lids ___, square for measuring the depth of density hole ___, calipers to measure diameter of sleeve ___, dishes ___, pans ___

8. Calibration:
8.1. Determine calibration equation in accordance w/ Annex A1 ___
8.2.1. Use vernier caliper or inside micrometer caliper to get inside dia. of sleeve ___
8.2.2. If more than 1 sleeve used, dia. of sleeves not differ > 0.05 in. (1.3 mm) __
8.2.3. If worn > 0.05 in. (1.3 mm), don't use either sleeve, or perform new calibration ___

9. Procedure:
9.1. Prepare smooth, level area, place baseplate make sure no air gaps, & nail into place ___
9.1.1. Take care not to apply pressure on soil surface ___
9.2. Assemble sleeve w/ driver ___
9.3. Remove driver & extract mat'l from inside sleeve ___
9.4. As full depth is approached, flatten bottom of hole while extracting soil ___
9.5. Seal container w/ soil to preserve in-place water content ___
9.6. Place measurement plate on soil @ bottom of hole & rotate gently to seat ___
Measure depth of hole from top of msrmt plate to top of baseplate w/ trisquare or machinist's square ___
2 msrmts 180° apart ___
9.7. Calculate avg. depth of hole @ 2 opposite keystocks, & avg. of other 2 keystocks ___
If the 2 avg. depths are not w/in 0.05 in. (1.3 mm) of each other, remeasure ___
9.8. Weigh soil removed from test hole ___
9.9. Get water content in accordance w/ D 2216 ___
9.10. Calculate dry wt of mat'l removed from hole ___
9.11. Calculate dry wt per in. of test hole ___
9.12. Use calibration equation, calculate in-place dry density ___

10. Calculation ___

11. Report ___

Data forms ___

S___F___N/A___

Determination of Water Content of Soil by the Microwave Oven Heating
ASTM D 4643-00

6. Apparatus:
6.1. Microwave oven ___
6.2. Balance with min. capacity of 1000-g and a 0.1-g read conforming to ASTM D 4753-952 ___
6.3. Specimen containers ___
6.4. Container handling apparatus, glove or holder ___
6.5. Desiccator, silica gel or anhydrous calcium sulfate ___
6.6. Heat sink, material or liquid placed in microwave to absorb energy ___
6.7. Stirring tools, spatulas, putty knives, and glass rods ___

8. Samples:
8.1. Keep spls in noncorrodible airtight containers @ temp 3 – 30°C, in area avoiding direct sunlight ___
8.2. Water content performed as soon as practical after sampling ___

9. Test specimen:
9.1. For WC's determined as part of another ASTM method, spec. selection process & technique specified in that test method as follows:
9.2. Representative spl based on test method ___
9.2.1. Bulk spls thoroughly mix, get spl size according to Table 1 ___
9.2.2. Small jar spls select according to following:
9.2.2.1. Cohesionless, mix thoroughly, get spl size according to Table 1 ___
9.2.2.2. Cohesive, remove 3 mm from periphery, slice in half, if layered see 9.2, get spl size according to Table 1 ___
9.3. Obtain 2nd spl if comparing to another test method ___

10. Conditioning:
10.1. Prepare & process as quickly as possible ___
10.2. Cut or break into sizes to aid in obtaining more uniform drying of specimen ___
10.3. If not tested immediately, store in sealed container ___

11. Procedure:
11.1. Get & record weight of clean dry container ___
11.2. Place soil in container, get & record weight ___
11.3. Place in microwave w/ heat sink, turn oven on for 3 min. ___
11.4. Remove from oven, weigh immediately or place in dessicator to cool, weigh ___
11.5. Carefully mix soil w/ one of the stirring tools, taking care not to lose any soil ___
11.6. Return to oven & heat for 1 min. ___
11.7. Repeat 11.4 – 11.6, until change between 2 weight determinations change ≤ 0.1 % ___
11.8. Use final weight determination for WC ___

12.1 Calculate WC ___

12. Report ___

Data Sheet ___

S___F___N/A___

Consolidated Undrained Triaxial Compression (R-Bar Test)
ASTM D 4767-95

5.2. Axial loading device accurate to ±1% of selected value ___
5.3. Axial load-measuring device accurate to 1% of axial load at failure (load ring/load cell) ___
5.4. Triaxial compression chamber ___
5.5. Axial load piston ___
5.6. Pressure and vacuum control device capable of applying pressure to ±0.25-psi for pressures < 28-psi and to within ±1% for pressures greater than 28-psi (regulator) ___
5.7. Pressure and vacuum measurement device with same tolerances as control device (gage) ___
5.8. Pore water pressure measurement device with same tolerances as control device (pressure transducer) ___
5.9. Volume change measurement device accurate to ±0.05% of total volume of specimen ___
5.10. Deformation indicator accurate to 0.25% of specimen height and range of at least 20% of specimen height (dial indicator, linear variable differential transformer (LVDT) ___
5.11. Specimen cap and base ___
5.12. Porous disks one at each end of specimen ___
5.13. Filter paper strips and disks ___
5.14. Rubber membrane and O-rings ___
5.15. Valves for checking volume changes ___
5.16. Specimen size measurement device accurate to 0.1% (pi tape, calipers) ___
5.17. Recorders for taking specimen data (manual, electronic digital or analog) ___
5.18. Sample extruder ___
5.19. Timer to nearest 1-s ___
5.20. Balance readable to 0.1% of test mass ___
5.21. Water de-aeration device (if needed for saturating specimens) ___
5.22. Testing environment, no temperature fluctuations less than ± 4°C (± 7.2°F) ___
5.23. Miscellaneous Apparatus: specimen trimming tools - wire saw, steel straightedge, miter box, vertical trimming lathe, mold / tamper for compacting specimens, membrane and O-ring expander, water content cans ___

Procedure:

6.1. Specimen height to diameter ratio of 2 to 2.5 ___, EM 1110-2-1906 App. XI (not < 2.1) ___
Individual height or dia. measurement not vary from average by > 5% ___
Largest particle size < 1/6 specimen dia. ___
6.2. Three height measurements 120° apart, average ___, 3 dia. measured at quarter points, average ___
8.2.4.4. Specimen saturation, "B" value ≥ 0.95 ___; EM 1110-2-1906 App. X: "B" value ≥ 0.98 ___
8.3.4. Consolidate to 100% primary consolidation ___
8.3.5. Determine t_{50} (time to 50% consolidation in minutes) ___
8.4.2. Strain rate in % per minute = 4% / (10 x t_{50}) or slower if necessary ___
EM 1110-2-1906 App. X: 0.5%/min. for plastic soils, 0.3% / min. or less for brittle soils (R tests) ___
EM 1110-2-1906 App. X: at least 120-minute time to failure (R-bar tests) ___
8.4.2.1. Record load, deformation, & pore-water pressures at increments of 0.1 to 1% strain, & at every 1% thereafter ___; Continue loading to 15% strain, a drop of 20% of deviator stress, or when 5% additional strain occurs after a peak deviator stress ___

Report:

11.1.5. Initial specimen dry unit weight, void ratio, water content, % saturation ___
11.1.6. Initial height / dia. of specimen ___; 11.1.7. Method of saturation ___; 11.1.8. Total back pressure ___
11.1.9. Pore pressure parameter “B” at end of saturation ___; 11.1.10. Effective consolidation stress ___
11.1.11. Time to 50% primary consolidation ___; 11.1.12. Specimen dry unit weight, void ratio, water content, and % saturation after consolidation ___; 11.1.13. Specimen cross-sectional area after consolidation, and method used for determination ___ ; 11.1.14. Failure criterion (15% axial strain, max. effective stress ratio, etc.) ___;
11.1.15. Value of deviator stress at failure, values of effective minor and major principal stresses at failure ___;
11.1.16. Axial strain at failure, % ___; 11.1.17. Rate of strain, % / minute ___; 11.1.18. Deviator stress and induced pore-water pressure versus axial strain curves ___; 11.1.19. P’ – Q’ diagram ___; 11.1.20. Mohr stress circles based on total and effective stresses **(optional)** ___; 11.1.21. Slope of angle of the failure surface **(optional)** ___ ; 11.1.22. Failure sketch or photograph of the specimen ___; 11.1.23. Remarks ___
EM 1110-2-1906 App. X: Mohr stress circles and strength envelopes required ___;
Data forms ___

S___F___N/A___

Hydraulic Conductivity using a Flexible Wall Permeameter
(permeability of soil less than or equal to 1 x 10^{-3}-cm/s)
ASTM D 5084-00

5. Apparatus:
5.1. Constant head (Method A), falling head (Methods B & C), constant rate of flow (Method D), constant volume-constant head (Method E), or constant volume-falling head (Method F) ___
5.1.1. Constant head, maintain constant hydraulic pressures to w/in ±5% ___
5.1.2. Falling head, capable of measuring hydraulic gradient to w/in ±5% ___
5.1.3. Constant rate of flow, capable of maintaining constant flow rate w/in ±5% ___
5.1.4. Constant volume-constant head (CVCH), maintain head loss to w/in ±5% ___
5.1.5. Constant volume-falling head (CVFH), with mercury to create head loss, meet criteria in 5.1.2 ___
5.1.6. System de-airing ___
5.1.7. Back pressure system, 5% or better of the applied load ___
5.2. Flow measurement system ___
5.2.1. Flow accuracy, 5 % or better ___
5.2.2. De-airing & compliance of system ___
5.2.3. Head losses ___
5.3. Permeameter cell pressure system, apply & control to w/in 5% of applied pressure ___
5.4. Permeameter cell ___
5.4.3. Top cap & base, impermeable & rigid ___
5.4.4. Flexible membranes w/ O-rings ___
5.4.5. Porous end pieces ___
5.4.6. Filter paper ___
5.5. Equipment for compacting specimens ___
5.6. Sample extruder ___
5.7. Trimming equipment
5.8. Specimen size measurement device measuring to 0.01-in. (pi tape, calipers) ___
5.9. Balances, readable to 0.1 % ___
5.10. Equipment for mounting specimen, membrane stretcher & ring for expanding O-rings ___
5.11. Vacuum pump ___
5.12. Temperature maintaining device, either constant temp room or device to maintain temp ___
5.13. Water content containers ___
5.14. Oven, 110 ± 5°C (230 ± 9°F) ___

8. Test specimens:
8.1. Size, Min specimen size (diameter of 1.0-in. by 1.0-in. high) measured to 0.01-in. or better ___
8.2. Undisturbed specimens ___
8.3. Lab-compacted specimens ___

9. Procedure:
9.1. Specimen setup, place filter strips & membrane, attach lines, assemble cell ___
9.2. Specimen soaking (optional), partial vacuum may be used ___
9.3. Backpressure saturation, “B” = ≥ 0.95 ___
9.4. Consolidation ___
9.5. Permeation:
9.5.1. Hydraulic gradient ___
9.5.2. Initialization ___
9.5.3. Constant head (Method A & E) ___
9.5.4. Falling-head (Methods B, C & F) ___
9.5.5. Constant rate of flow (Method D) ___

10. Calculation ___

10. Report ___

Data forms ___

S___F___N/A___

General Equipment

Oven 110 ± 5°C (ASTM E 145-94):

1. Make_____ Mod. No._____ Top/Bottom Temp._____ Cap. OK_____

2. Make_____ Mod. No._____ Top/Bottom Temp._____ Cap. OK_____

3. Make_____ Mod. No._____ Top/Bottom Temp._____ Cap. OK_____

4. Make_____ Mod. No._____ Top/Bottom Temp._____ Cap. OK_____

Calibration data_____

Evaluating, Selecting, and Specifying Balances for Use in Soil, Rock, and Construction Materials Testing
ASTM D 4753-95

a. Class GP1, readable to 0.01-g, accurate to ± 0.02-g < 20-g; ± 0.1% of test mass ≥ 20-g:

1. Make _____ Model No. _____ Serial No. _____Capacity _____
Calibrated (Date) _____ Test Load(s) _____ Reading (s) _____

2. Make _____ Model No. _____ Serial No. _____Capacity _____
Calibrated (Date) _____ Test Load(s) _____ Reading (s) _____

b. Class GP2, readable to 0.1-g, accurate to ± 0.2-g < 200-g; ± 0.1% of test mass ≥ 200-g:

1. Make _____ Model No. _____ Serial No. _____Capacity _____
Calibrated (Date) _____ Test Load(s) _____ Reading (s) _____

2. Make _____ Model No. _____ Serial No. _____Capacity _____
Calibrated (Date) _____ Test Load(s) _____ Reading (s) _____

c. Class GP5, readable to 1.0-g, accurate to ± 2.0-g < 2000-g; ± 0.1% of test mass ≥ 2000-g:

1. Make _____ Model No. _____ Serial No. _____Capacity _____
Calibrated (Date) _____ Test Load(s) _____ Reading (s) _____

2. Make _____ Model No. _____ Serial No. _____Capacity _____
Calibrated (Date) _____ Test Load(s) _____ Reading (s) _____

d. Class GP10, readable to 5.0-g, accurate to ± 5.0-g < 5000-g; ± 0.1% of test mass ≥ 5000-g:

1. Make _____ Model No. _____ Serial No. _____Capacity _____
Calibrated (Date) _____ Test Load(s) _____ Reading (s) _____

2. Make _____ Model No. _____ Serial No. _____Capacity _____
Calibrated (Date) _____ Test Load(s) _____ Reading (s) _____

e. Class GP100, readable to 50.0-g, accurate to ± 50.0-g < 50000-g; ± 0.1% of test mass ≥ 50000-g:

1. Make _____ Model No. _____ Serial No. _____Capacity _____
Calibrated (Date) _____ Test Load(s) _____ Reading (s) _____

2. Make _____ Model No. _____ Serial No. _____Capacity _____
Calibrated (Date) _____ Test Load(s) _____ Reading (s) _____

S___F___N/A___

Wire Cloth and Sieves
ASTM E 11-95

4.5. Wires constructed to be rigid (tight) when in use within frame
4.6. Wire cloth with no punctures or obvious defects
5.1 Wire cloth mounted on frame with no distortion, looseness, or waviness with smooth joint so that no material is trapped between the wire cloth and the frame. Look for tears, cracks, creases, dents in frames, etc.
A1.2. Excessive foreign matter in the cloth

Sieve Size	200-mm (8-in.)	300-mm (12-in.)	Gilson
150-mm (6-in.)			
125-mm (5-in.)			
100-mm (4-in.)			
90-mm (3½-in.)			
75-mm (3-in.)			
63-mm (2½-in.)			
50-mm (2-in.)			
37.5-mm (1½-in.)			
31.5-mm (1¼-in.)			
25.0-mm (1-in.)			
19.0-mm (3/4-in.)			
16.0-mm (5/8-in.)			
12.5-mm (1/2-in.)			
9.5-mm (3/8-in.)			
8.0-mm (5/16-in.)			
6.3-mm (1/4-in.)			
4.75-mm (No. 4)			
4.00-mm (No. 5)			
(No. 6)			
2.36-mm (No. 8)			
2.00-mm (No. 10)			
1.70-mm (No. 12)			
1.16-mm (No. 16)			
850-µm (No. 20)			
600-µm (No. 30)			
425-µm (No. 40)			
300-µm (No. 50)			
250-µm (No. 60)			
180-µm (No. 80)			
150-µm (No. 100)			
106-µm (No. 140)			
75-µm (No. 200)			